

Identity of parasitoid wasps (Hymenoptera, Braconidae and Eulophidae) reared from aquatic leaf-mining flies (Diptera, Ephydriidae) on invasive Brazilian waterweed *Egeria densa* in South Africa

Simon van Noort^{1,2}, Rosali Smith³, Julie A. Coetzee³

1 Research and Exhibitions Department, South African Museum, Iziko Museums of South Africa, P.O. Box 61, Cape Town, 8000, South Africa **2** Department of Biological Sciences, University of Cape Town, Private Bag, Rondebosch, 7701, South Africa **3** Department of Zoology and Entomology, Centre for Biological Control, Rhodes University, Grahamstown, South Africa

Corresponding author: Simon van Noort (svannoort@iziko.org.za)

Academic editor: D. Brothers | Received 6 January 2021 | Accepted 1 February 2021 | Published 9 March 2021

<http://zoobank.org/DD1C3651-0E8A-4F50-8D66-32474969C0F3>

Citation: van Noort S, Smith R, Coetzee JA (2021) Identity of parasitoid wasps (Hymenoptera, Braconidae and Eulophidae) reared from aquatic leaf-mining flies (Diptera, Ephydriidae) on invasive Brazilian waterweed *Egeria densa* in South Africa. African Invertebrates 62(1): 287–314. <https://doi.org/10.3897/AfrInvertebr.62.62842>

Abstract

The Brazilian waterweed, *Egeria densa* Planchon, 1849 (Hydrocharitaceae), is an invasive species in South Africa where it is a host plant for the aquatic leaf-miner *Hydrellia egeriae* Rodrigues-Júnior, 2015 (Ephydriidae, Diptera). Efficacy of the biocontrol agent can potentially be affected by parasitoids. Three species of braconid parasitoid wasps were reared from puparia of *Hydrellia egeriae*. By comparison with the type specimens, these species have been determined to be *Ademon lagarosiphonae* van Achterberg, 2012 (Braconidae: Opiinae), *Chaenusa anervata* van Achterberg, 2012 and *Chaenusa seminervata* van Achterberg, 2012 (Braconidae: Alysiinae: Dacnusiini), all previously recorded as parasitoids of an ephydrid dipterous aquatic leaf-miner, *Hydrellia lagarosiphon* Deeming, 2012, on *Lagarosiphon major* (Ridley, 1886) Moss ex Wager (Hydrocharitaceae) in South Africa. The chalcidoid, *Janicharis africanus* Gumovsky & Delvare, 2006 (Eulophidae), was also reared from *Hydrellia egeriae* and is possibly a hyperparasitoid of the braconids. South Africa is a new country record for *J. africanus*. We provide comprehensive images of all species including the braconid types and illustrated identification keys to the Afrotropical species of the two braconid genera are also provided. All images and online keys are available on WaspWeb (<http://www.waspweb.org>).

Keywords

Ademon, Alysini, aquatic weeds, biocontrol, *Chaenusa*, Entedoninae, *Hydrellia egeriae*, Hydrocharitaceae, *Janicharis*, Opiinae

Introduction

Egeria densa Planchon, 1849, Hydrocharitaceae (Brazilian waterweed; also known as leafy elodea or dense waterweed) is a rooted submerged aquatic macrophyte native to Brazil, Argentina and Uruguay (Cook and Urmi-König 1984; Cabrera Walsh et al. 2013). Stems are elongate, with a diameter of between 1 and 3 mm and irregular side branching (Cook and Urmi-König 1984). It prefers still to slow-moving water and can grow until it reaches the water surface (Yarrow et al. 2009). Leaves are small (10 to 44 mm long, 1.5 to 4.5 mm wide) and are characteristically grouped as four leaves per whorl (Cook and Urmi-König 1984). Vegetative growth occurs at double nodes on stems, which can either produce flowers, lateral branches or root buds (Yarrow et al. 2009). *Egeria densa* has been distributed around the world because it is an “oxygenator” and has a simple anatomy, making it an ideal aquarium and study plant (Yarrow et al. 2009; Coetzee et al. 2011a; June-Wells et al. 2012). Due to its ability to grow from fragments, it has established and become invasive in many countries (Hussner et al. 2017). In South Africa, it has taken advantage of open, eutrophic water following the successful management of floating aquatic weeds (Coetzee et al. 2011a). *Egeria densa* grows vigorously in eutrophic systems, which allows it to form dense uniform stands, with negative ecological, economic and societal impacts on the invaded system (Vundla et al. 2017; Smith et al. 2019).

A biocontrol investigation, conducted by the Centre for Biological Control at Rhodes University (South Africa) on the invasive Brazilian waterweed, produced four species of parasitoid wasps belonging to two families. These were reared from puparia of the ephydrid fly, *Hydrellia egeriae* Rodrigues-Júnior, 2015, a phytophagous biological control agent attacking *Egeria densa*. The Ephydridae contain a number of important naturally-occurring biological control agents of submerged invasive waterweeds (Wheeler and Center 2001; Baars et al. 2010; Coetzee et al. 2011a, b; Cabrera Walsh et al. 2013; Bownes 2014). These flies are attacked by braconid parasitoid wasps mainly belonging to the genera *Ademon* Haliday, 1833 and *Opius* Wesmael, 1835 (subfamily Opiinae); and *Chaenusa* Haliday, 1839 and *Chorebus* Haliday, 1833 (tribe Dacnusi, subfamily Alysini) (Yu et al. 2016). Both *Ademon* and *Chaenusa* contain aquatic parasitoid species of *Hydrellia* Robineau-Desvoidy, 1830 flies (Diptera, Ephydridae) (Kula and Zolnerowich 2008; van Achterberg and Prinsloo 2012; Kula and Harms 2016). We here provide determinations and photographs of the four species of parasitoid wasps recorded from puparia of the aquatic leaf-miner, *Hydrellia egeriae* developing on Brazilian waterweed *Egeria densa* to facilitate ongoing investigation into the efficacy of *Hydrellia egeriae* as a biocontrol agent in South Africa. We also provide illustrated identification keys to the species of the two braconid genera occurring in Africa.

Materials and methods

Photography

Images were acquired at SAMC with a Leica LAS 4.9 imaging system, comprising a Leica Z16 microscope with a Leica DFC450 Camera and 0.63× video objective attached. The imaging process, using an automated Z-stepper, was managed using the Leica Application Suite V. 4.9 software installed on a desktop computer. Diffused lighting was achieved using a Leica LED 5000 Dome.

Depositories

CASC	California Academy of Sciences, San Francisco, USA (Curator: Brian Fisher);
CIRAD	Centre de Coopération Internationale en Recherche Agronomique pour le Développement (Curator: Philippe Lachenaud);
MNHN	Muséum national d'Histoire naturelle, Paris (Curator: Bernardo Santos);
NHMUK	Natural History Museum, London (Curator: Gavin Broad);
RMNH	Naturalis Biodiversity Center, Leiden (Curator: Luc Willemse);
SAMC	Iziko South African Museum, Cape Town, South Africa (Curator: Simon van Noort);
SANC	National Collection of Insects, ARC, Pretoria (Curator: Vivienne Uys).

Results

Four parasitoid wasp species belonging to two families (Braconidae and Eulophidae) were reared from puparia of *Hydrellia egeriae* on *Egeria densa*. The three braconids, through comparison with the type specimens, were determined to be *Ademon lagarosiphonae* van Achterberg, 2012 (Opiinae), *Chaenusa anervata* van Achterberg, 2012 and *Chaenusa seminervata* van Achterberg, 2012 (Alysiinae), described from specimens reared from an aquatic ephydrid leafminer, *Hydrellia lagarosiphon* Deeming, 2012 on *Lagarosiphon major*, (Ridley, 1886) Moss ex Wager also of the family Hydrocharitaceae. The chalcidoid, *Janicharis africanus* Gumovsky & Delvare, 2006 (Eulophidae) was also reared from this ephydrid fly and is likely a hyper-parasitoid of the braconids.

All images included in this paper, as well as additional images and online interactive keys to the braconid species are available on WaspWeb (<http://www.waspweb.org>) (van Noort 2021):

<http://www.waspweb.org/Ichneumonoidea/Braconidae/Alysiinae/index.htm>

<http://www.waspweb.org/Ichneumonoidea/Braconidae/Opiinae/index.htm>

<http://www.waspweb.org/Ichneumonoidea/Braconidae/Keys/index.htm>

<http://www.waspweb.org/Chalcidoidea/Eulophidae/Entedoninae/Janicharis/index.htm>

Family Braconidae

Subfamily Alysiinae Leach, 1815

Tribe Dacnusiini Foerster, 1862

Genus *Chaenusa* Haliday, 1839

Alysia (*Chaenusa*) Haliday, 1839: 19. Type species: *Bracon conjungens* Nees von Esenbeck, 1812 (1811), by monotypy; type destroyed.

Chorebidea Viereck, 1914: 32. Type species: *Alysia* (*Chorebus*) *nereidum* Haliday, 1839, by original designation and monotypy. Treated as *Chaenusa* (*Chorebidea*) Viereck, 1914 (Zaykov 1986).

Chorebidea Nixon, 1943: 28. Preoccupied. Type species: *Alysia* (*Chorebus*) *naiadum* Haliday, 1839, by original designation and monotypy.

Chorebidella Riegel, 1950: 125. Type species: *Chorebidella bergi* Riegel, 1950, by original designation and monotypy.

Diagnosis. See Kula and Zolnerowich 2008.

Distribution. Afrotropical, Australian, Nearctic, Neotropical, Oriental and Palaearctic Regions (Kula and Zolnerowich 2008; Yu et al. 2016).

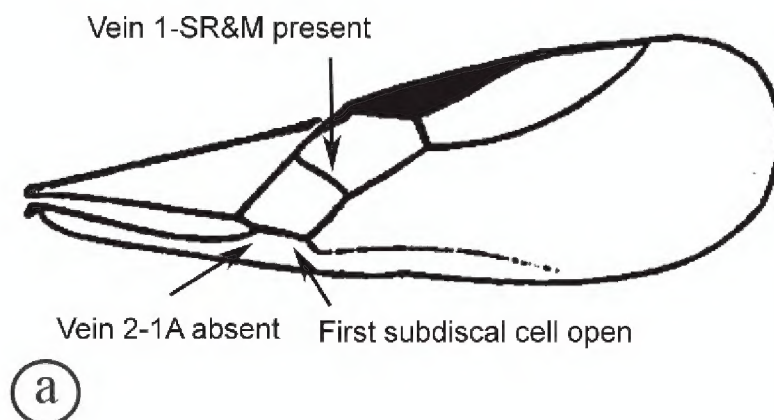
Key to the Afrotropical species of the genus *Chaenusa* Haliday

Modified after van Achterberg and Prinsloo 2012.

- 1 Vein 2–1A of forewing completely developed, resulting in a closed first subdiscal cell (A); vein 1-SR+M of forewing absent or, when present, largely unsclerotised (A); apical half of metasoma of female largely depressed (B); body black; face strongly narrowed in females, ventrally narrower than high (C) (subgenus *Chaenusa* Haliday, 1839)..... 2



- Vein 2–1A of forewing largely absent, resulting in an open first subdiscal cell (a); vein 1-SR+M of forewing sclerotised, complete (a); apical half of metasoma of female strongly compressed; body largely reddish-brown; female face slightly wider than high (subgenus *Chorebidea* Viereck, 1914) *Chaenusa testacea*



- 2 Frons (fr) and face polished (A); face and eyes (ep) sparsely pubescent (A); each scutellar fovea (sf) with 2 or 3 longitudinal septa (A); first tergite (1t) longer than posteriorly wide, laterally strigous, medially rugulose (B); vein 1-SR+M of forewing pigmented, but largely unsclerotised (C); distal end of pterostigma (pt) comparatively elongate (C) ***Chaenusa seminervata***



- Frons (fr) and face granulate (a); face and eyes (ep) densely pubescent (a); each scutellar fovea (sf) with no obvious longitudinal septa (a); first tergite (1t) as long as posteriorly wide, overall rugulose without longitudinal strigae (b); vein 1-SR+M of forewing absent (c); distal end of pterostigma (pt) comparatively shorter and more robust (c)..... ***Chaenusa anervata***



***Chaenusa (Chaenusa) anervata* van Achterberg, 2012**

Figs 1–4

Holotype. SOUTH AFRICA • female; Mpumalanga Prov., Lydenburg Fisheries, Lydenburg; 25°11'S, 30°48'E; 21.xi.2008; J.R. Baars, J.A. Coetzee, G.D. Martin; ex leaf-miner on *Lagarosiphon major* Hydrocharitaceae (SANC examined).

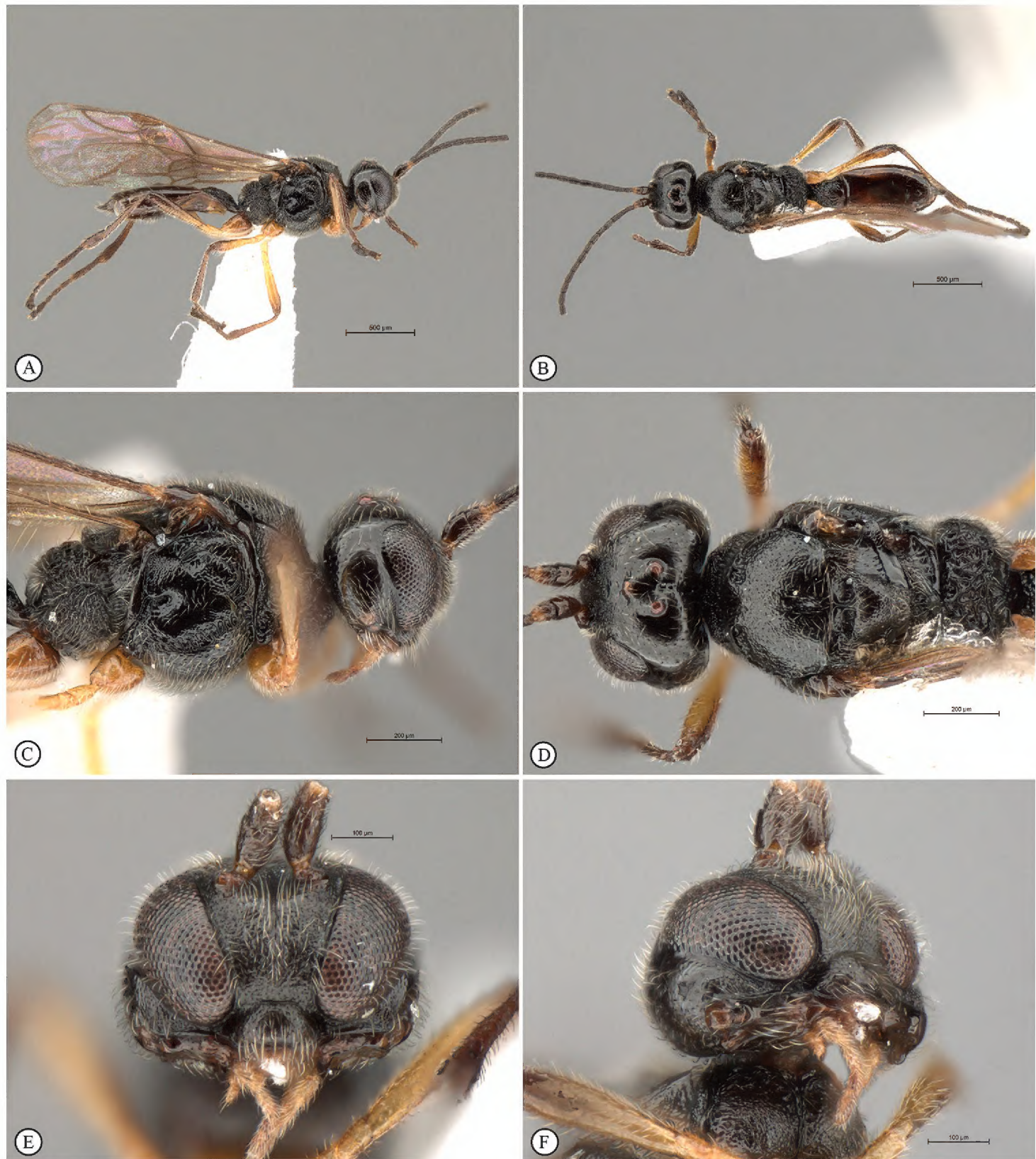


Figure 1. *Chaenusa anervata* Holotype female TYPH01927 (SANC) **A** habitus, lateral view **B** habitus, dorsal view **C** head and mesosoma, lateral view **D** head and mesosoma, dorsal view **E** head, anterior view **F** head, ventrolateral view.

Paratypes. SOUTH AFRICA • 1 female; KwaZulu-Natal Prov., Mooi River, Mearns Dam; 29°25'S, 29°97'E; 18.xi.2008; J.R. Baars, J.A. Coetzee, G.D. Martin; ex leaf-miner on *Lagarosiphon major* Hydrocharitaceae (RMNH not seen) • 1 male: Underberg, Farm Dam on Bushman's Nek road; 30°27'S, 29°14'E; 16.xi.2008 (SANC examined) • 1 male; Mooi River, Mearns Weir, 29°15'S, 29°57'E, 17.xi.2008 (RMNH not seen).



Figure 2. *Chaenusa anervata* Holotype female TYPH01927 (SANC) **A** propodeum and metasoma, dorsal view **B** propodeum and metasoma, lateral view **C** scutellum, metanotum and propodeum, dorsal view **D** first tergite, dorsal view **E** wings **F** data labels.

Other material. SOUTH AFRICA • 1 male; *KwaZulu-Natal*, Midmar Dam, 29°32'21.35"S, 30°11'40.15"E, June 2019, R. Smith, Collected from *Egeria densa* infestation with *Hydrellia egeriae* pupae, reared in lab, MDMR-FOR-R05, SAM-HYM-P092803 (SAMC).

Biology. Parasitoid of aquatic leaf-mining flies (Ephydridae): *Hydrellia lagarosiphon* on *Lagarosiphon major* (Hydrocharitaceae) and *Hydrellia egeriae* on *Egeria densa* (Hydrocharitaceae).



Figure 3. *Chaenusa anervata* Paratype male (SANC) **A** habitus, lateral view **B** habitus, dorsal view **C** head, anterior view **D** wings, inset: data labels.

Distribution. South Africa.

Comments. According to van Achterberg and Prinsloo (2012), this species is similar to *Chaenusa glabra* Kula, 2009 (India, Pakistan), which has a two-segmented labial palp (three-segmented in *C. anervata* and *C. seminervata*), females with 12–14 antennal segments (at least 15 in *C. anervata* and 16–18 in *C. seminervata*) and males with 14–17 segments (22 in *C. anervata* and 17–24 in *C. seminervata*). The body is brown or brownish-yellow as opposed to black in *C. anervata* and *C. seminervata* (van Achterberg and Prinsloo 2012). Other sexually dimorphic characters in *C. anervata* encompass the forewing pterostigma, which is light brown in females and dark brown in males; the male first metasomal tergite is generally longer (1.1–1.3 times its apical width) than in the female (1.1 times apical width) (van Achterberg and Prinsloo 2012); in addition, the compound eyes in females converge far more strongly (narrowest ventral width of face 0.55× broadest dorsal width) towards the clypeus than in the males (narrowest ventral width of face 0.90× broadest dorsal width); however, the overall relative dimensions of the face relative to the broadest width just below the toruli are equivalent in the two sexes, being slightly wider than high (females H:W = 9:10; males H:W = 10:11).



Figure 4. *Chaenusa anervata* male SAM-HYM-P092803 (SAMC) **A** habitus, lateral view **B** habitus, dorsal view **C** head, anterior view **D** wings, inset: data labels.

Chaenusa (Chaenusa) seminervata van Achterberg, 2012

Figs 5–9

Holotype. SOUTH AFRICA • female; Mpumalanga Prov., Lydenburg Fisheries, Lydenburg; 25°11'S, 30°48'E; 21.xi.2008; J.R. Baars, J.A. Coetzee, G.D. Martin; ex leaf-miner on *Lagarosiphon major* Hydrocharitaceae (SANC examined).

Paratypes. SOUTH AFRICA • 1 female; Mpumalanga Prov., Belfast, Lakenvlei Wetland; 25°60'S, 30°05'E (RMNH not seen) • 1 male; KwaZulu-Natal Prov., Stillwater Dam, Rosetta; 29°30'S, 29°07'E; 17.xi.2008; J.R. Baars, J.A. Coetzee, G.D. Martin; ex leaf-miner on *Lagarosiphon major* Hydrocharitaceae (RMNH not seen) • 4 males; Dieu Donne Farm Dam, Sani Pass; 29°68'407"S, 29°48'949"E; 16.xi.2008; J.R. Baars, J.A. Coetzee, G.D. Martin; reared from leaf-miner on *Lagarosiphon major* (Hydrocharitaceae) (SANC examined, RMNH not seen).

Other material. SOUTH AFRICA • 1 male; *KwaZulu-Natal*, Midmar Dam, 29°32'21.35"S, 30°11'40.15"E, June 2019, R. Smith, collected from *Egeria densa* infestation with *Hydrellia egeriae* pupae, reared in lab, MDMR-FOR-R01, SAM-HYM-P092800 (SAMC) • 1 female, idem, except MDMR-FOR-R02, SAM-HYM-P092801

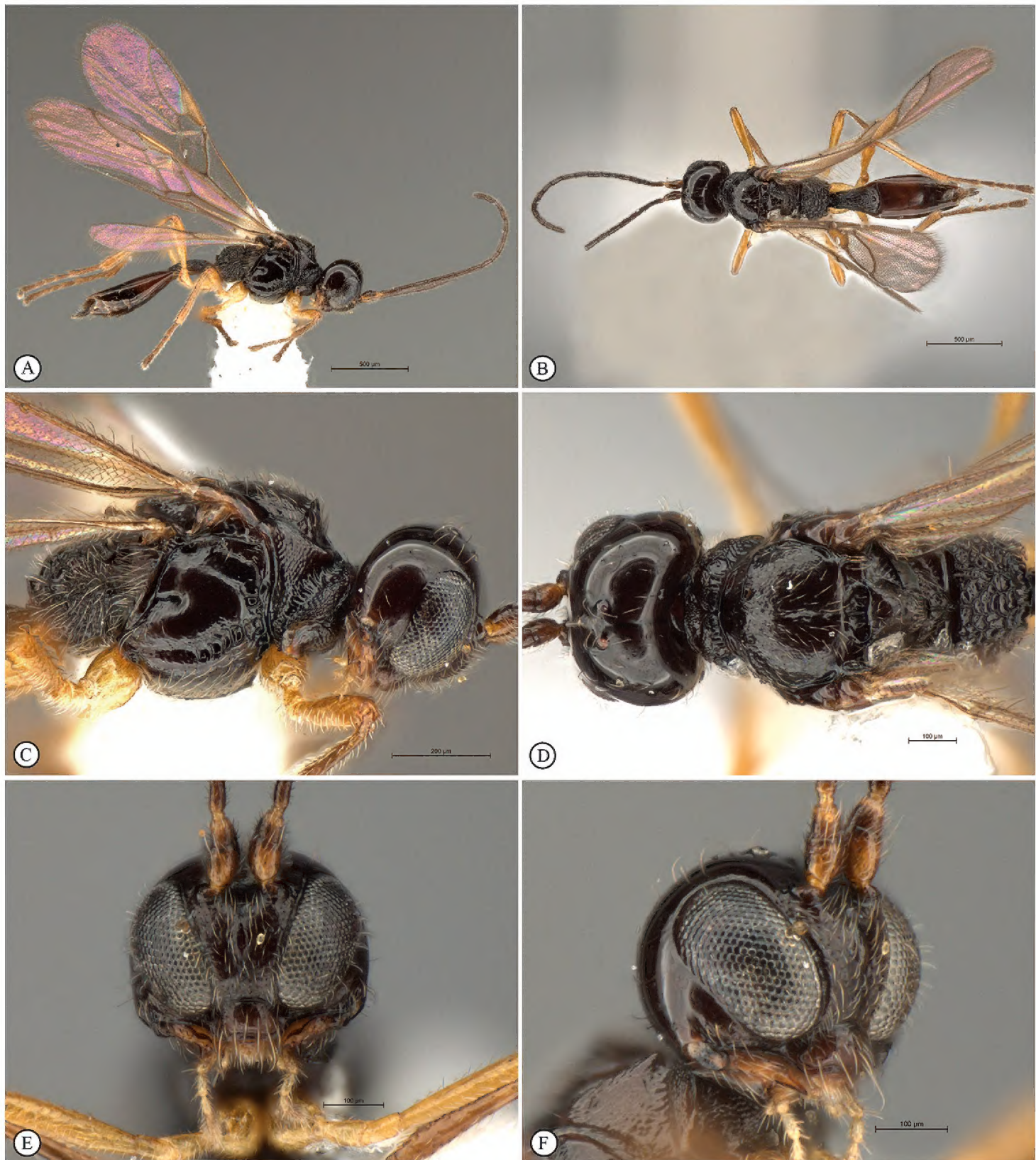


Figure 5. *Chaenusa seminervata* Holotype female TYPH01928 (SANC) **A** habitus, lateral view **B** habitus, dorsal view **C** head and mesosoma, lateral view **D** head and mesosoma, dorsal view **E** head, anterior view **F** head, ventrolateral view.

(SAMC) • 1 male, idem, except MDMR-FOR-R04, SAM-HYM-P092802 (SAMC) • 1 male, idem, except MDMR-FOR-R09, SAM-HYM-P092804 (SAMC) • 1 male, idem, except MDMR-FOR-R10, SAM-HYM-P092805 (SAMC) • 1 male, idem, except MDMR-FOR-R14, SAM-HYM-P092806 (SAMC).

Biology. Parasitoid of aquatic leaf-mining flies (Ephydriidae): *Hydrellia lagarosiphon* on *Lagarosiphon major* (Hydrocharitaceae) and *Hydrellia egeriae* on *Egeria densa* (Hydrocharitaceae).



Figure 6. *Chaenusa seminervata* Holotype female TYPH01928 (SANC) **A** propodeum and metasoma, dorsal view **B** propodeum and metasoma, lateral view **C** mesosoma and first tergite, dorsal view **D** propodeum and first tergite, dorsal view **E** wings **F** data labels.

Distribution. South Africa.

Comments. The Neotropical species *Chaenusa aurantium* Kula & Martinez, 2009 was reared from an undescribed species of *Hydrellia* in Argentina under evaluation for control of *Egeria densa* in the United States (Kula et al. 2009). *Chaenusa seminervata* keys to *C. aurantium* (terminal maxillary palpomere is brown) in the key to New World species (Kula and Zolnerowich 2008; Kula et al. 2009), but it is distinct from *C. aurantium* in head colour, sculpture and setation of the frons, as well as

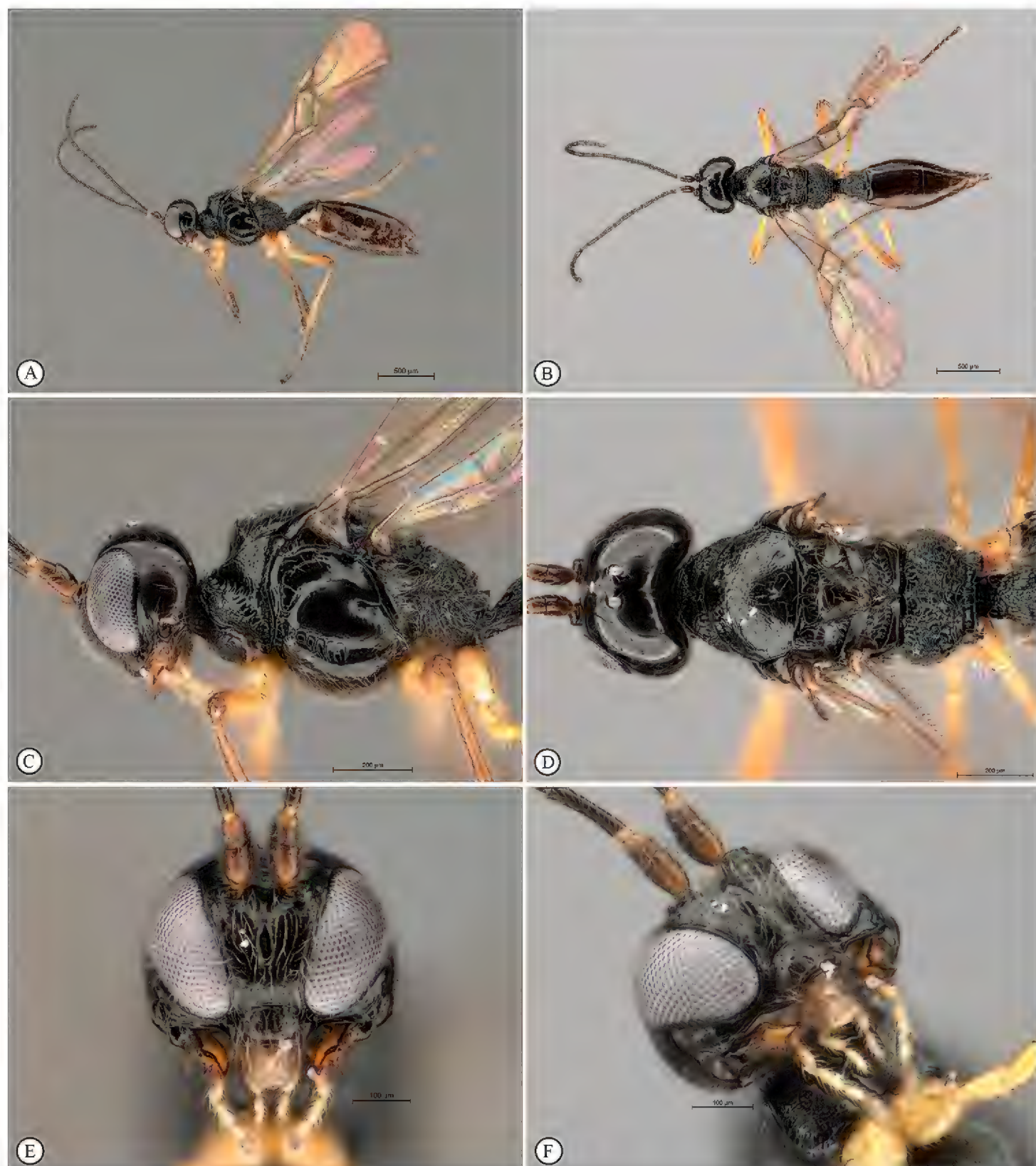


Figure 7. *Chaenusa seminervata* female SAM-HYM-P092801 (SAMC) **A** habitus, lateral view **B** habitus, dorsal view **C** head and mesosoma, lateral view **D** head and mesosoma, dorsal view **E** head, anterior view **F** head, ventrolateral view.

mesoscutal, mesopleural and propodeal sculpture. Sexual dimorphism of *Chaenusa seminervata* is exhibited in the following characters: females with 16–18 antennal segments, males with 17–24 segments; the forewing pterostigma is light brown in females and dark brown in males; in addition, the compound eyes in females converge less strongly (narrowest ventral width of the face 0.75× broadest dorsal width)

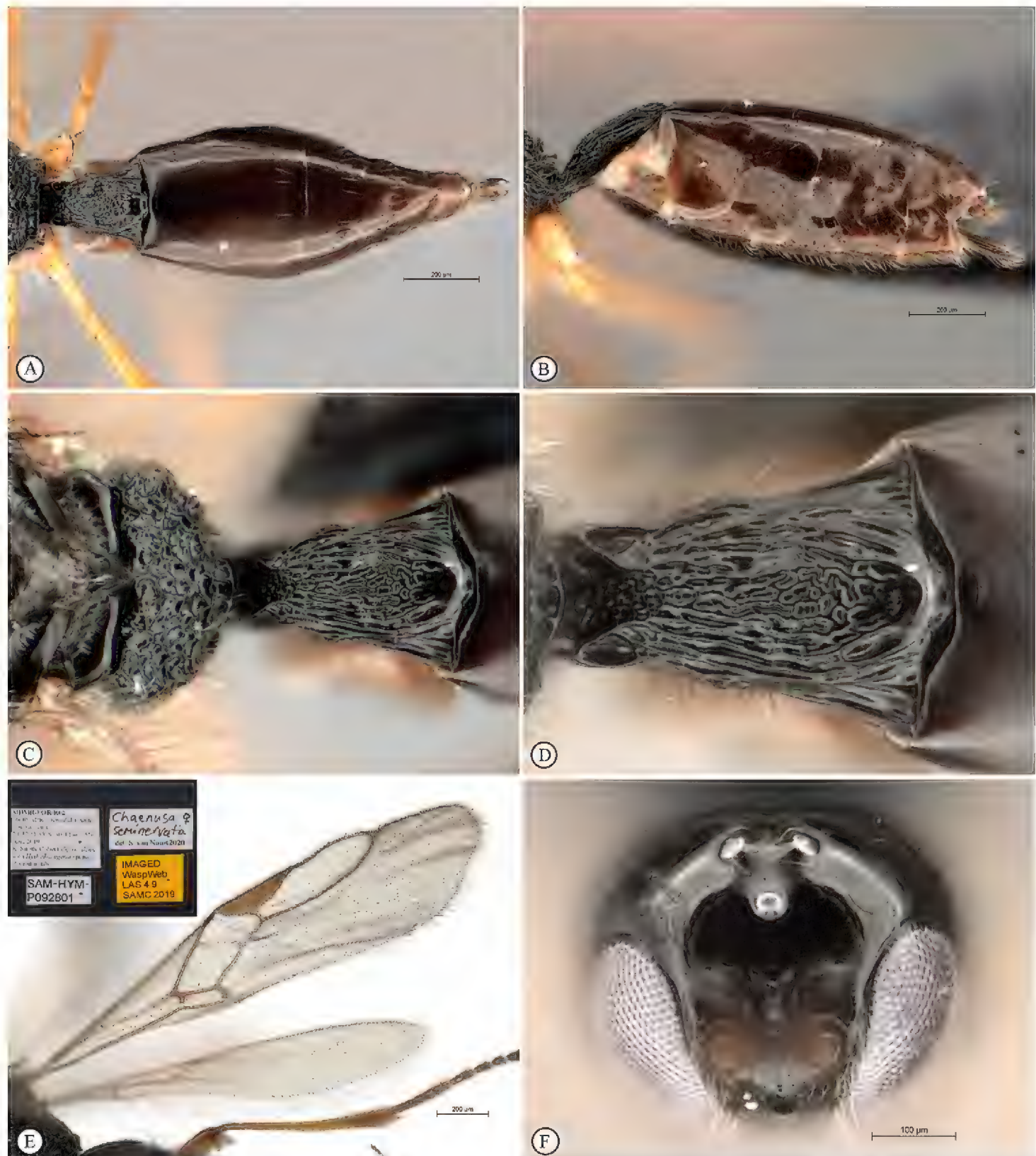


Figure 8. *Chaenusa seminervata* female SAM-HYM-P092801 (SAMC) **A** metasoma, dorsal view **B** metasoma, lateral view **C** scutellum, metanotum, propodeum and first tergite, dorsal view **D** first tergite, dorsal view **E** wings, inset: data labels **F** vertex of head.

towards the clypeus than in *C. anervata*, but still more strongly than in males (narrowest ventral width of the face $0.81\times$ broadest dorsal width); however, the overall relative dimensions of the face relative to the broadest width just below the toruli are equivalent in the two sexes, being slightly wider than high (females H:W = 10:12; males H:W = 9:11).

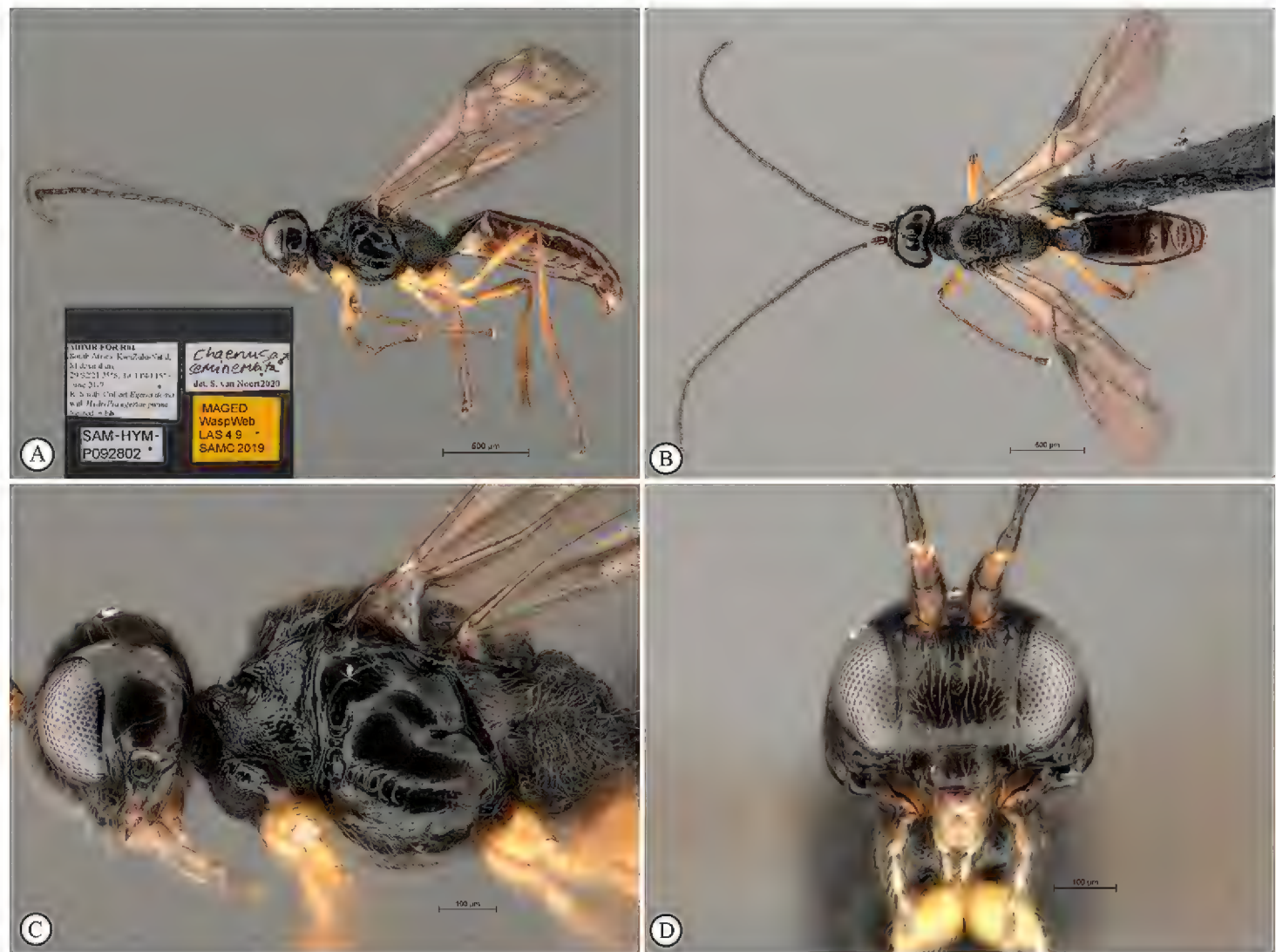


Figure 9. *Chaenusa seminervata* male SAM-HYM-P092802 (SAMC) **A** habitus, lateral view, inset: data labels **B** habitus, dorsal view **C** head and mesosoma, lateral view **D** head, anterior view.

***Chaenusa (Chorebidea) testacea* (Granger, 1949)**

Chorebidea testacea Granger, 1949.

Syntypes. MADAGASCAR • 2 females, 1 male; (MNHN). Types not seen.

Biology. Unknown.

Distribution. Madagascar.

Subfamily Opiinae Blanchard, 1845

Tribe Opiini Blanchard, 1845

Subtribe Ademonina Fischer, 1964

Genus *Ademon* Haliday, 1833

Ademon Haliday, 1833: 266. Type species: *Bracon decrescens* Nees von Esenbeck, 1812 (1811), by monotypy; type destroyed.

Lytacra Foerster, 1863: 266. Type species: *Lytacra stygia* Foerster, 1863, by monotypy and original designation.

Giardinaia de Stefani-Perez, 1902. Type species: *Giardinaia urinator* de Stefani, 1902, by monotypy.

Analostania Viereck, 1916. Type species: *Analostania tenuipes* Viereck, 1916, by monotypy and original designation.

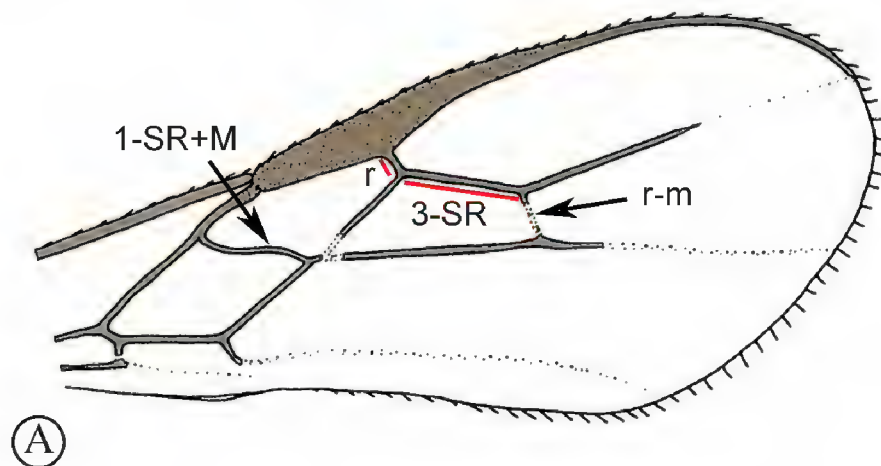
Diagnosis. Heavily-sculptured body with presence of an epicnemial carina (= prepectal carina), more or less developed ventrally; occipital carina complete dorsally; malar suture absent; crenulate depression above eye present; vein SR1 of forewing incomplete, not reaching the wing margin and resulting in an open marginal cell; medio-posteriorly scutellum with continuation of lateral elevated area; hind tibia, tarsus and tarsal claws very slender; second metasomal tergite distinctly longer than third tergite and second metasomal suture distinct (Wu et al. 2014; Wharton 2021).

Distribution. Afrotropical, Nearctic, Oriental and Palaearctic Regions (van Achterberg and Prinsloo 2012).

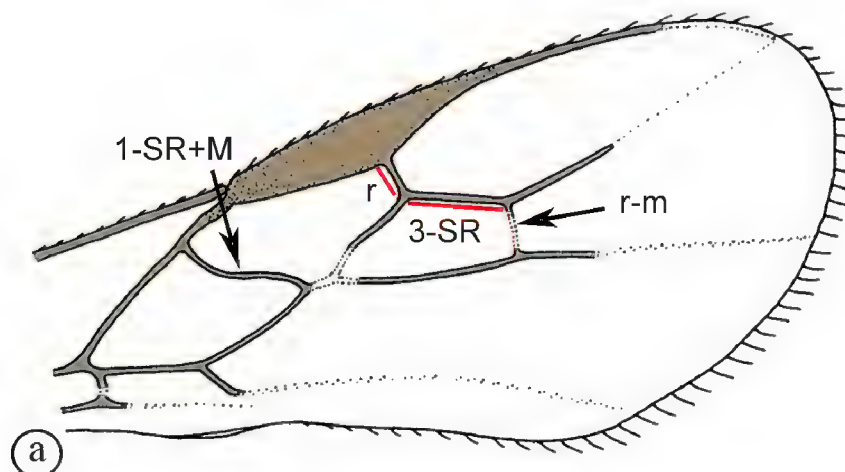
Key to the Afrotropical species of the genus *Ademon* Haliday

Line drawings modified from van Achterberg and Prinsloo 2012.

- 1 Vein 3-SR of forewing 5.0 times as long as vein r; vein 1-SR+M slightly sinuate; vein r-m inclivous (A).....*Ademon angolanus*



- Vein 3-SR 2.1–3.5 times as long as vein r; vein 1-SR+M usually strongly sinuate; vein r-m vertical or nearly so (a)*Ademon lagarosiphonae*



***Ademon angolanus* Fischer, 1963**

Holotype. ANGOLA • female; CAS-TYPE-10370 (CASC). Not seen.

Biology. Unknown.

Distribution. Angola.

***Ademon lagarosiphonae* van Achterberg, 2012**

Figs 10–16

Holotype. SOUTH AFRICA • female *Mpumalanga*, Lydenburg Fisheries, Lydenburg, 25°11'S, 30°48'E, 21.xi.2008, J.R. Baars, J.A. Coetzee, G.D. Martin, reared from leaf-miner on *Lagarosiphon major* (Hydrocharitaceae) (SANC examined).

Paratypes. SOUTH AFRICA • 1 female, 1 male; same data as for holotype (SANC examined).

Other material. SOUTH AFRICA • 1 male; Eastern Cape, East London, Nahoon River; 32°57'45.41"S, 27°54'41.59"E; 12 December 2018; R. Smith; Collected from *Egeria densa* infestation with *Hydrellia egeriae* pupae; SAM-HYM-P095098 (SAMC) • 1 female: idem; except for 9 May 2019; R. Smith; Collected from *Egeria densa* infestation with *Hydrellia egeriae* pupae; reared in lab; NHN-FOR-R01; SAM-HYM-P092742 (SAMC) • 1 male: idem; except for NHN-WINTER-FOR-R01; SAM-HYM-P092743 (SAMC) • 1 female: idem; except for NHN-FOR-R02; SAM-HYM-P092744 (SAMC) • 1 male: idem; except for NHN-FOR-R03; SAM-HYM-P092746 (SAMC) • 1 male: idem; except for NHN-FOR-R04; SAM-HYM-P092748 (SAMC) • 1 female: idem; except for NHN-FOR-R05; SAM-HYM-P092750 (SAMC) • 1 female: idem; except for NHN-FOR-R06; SAM-HYM-P092752 (SAMC) • 1 male: idem; except for July 2019; NHN-WINTER-FOR-R03; SAM-HYM-P092747 (SAMC) • 1 female: idem; except for NHN-WINTER-FOR-R04; SAM-HYM-P092749 (SAMC) • 1 male: idem; except for NHN-WINTER-FOR-R05; SAM-HYM-P092751 (SAMC) • 1 female: idem; except for NHN-WINTER-FOR-R06; SAM-HYM-P092753 (SAMC) • 1 female: idem; except for NHN-WINTER-FOR-R07; SAM-HYM-P092756 (SAMC) • 1 female: idem; except for NHN-WINTER-FOR-R08; SAM-HYM-P092757 (SAMC) • 1 male: idem; except for NHN-WINTER-FOR-R09; SAM-HYM-P092759 (SAMC) • 1 female: idem; except for NHN-WINTER-FOR-R10; SAM-HYM-P092760 (SAMC) • 1 male: idem; except for NHN-WINTER-FOR-R11; SAM-HYM-P092761 (SAMC) • 1 male: idem; except for NHN-WINTER-FOR-R12; SAM-HYM-P092764 (SAMC) • 1 female: idem; except for NHN-WINTER-FOR-R13; SAM-HYM-P092765 (SAMC) • 1 female: idem; except for NHN-WINTER-FOR-R14; SAM-HYM-P092767 (SAMC) • 1 male: idem; except for NHN-WINTER-FOR-R15; SAM-HYM-P092768 (SAMC) • 1 male: idem; except for NHN-WINTER-FOR-R16; SAM-HYM-P092769 (SAMC) • 1 female: idem; except for NHN-WINTER-FOR-R17; SAM-HYM-P092770 (SAMC) • 1 female: idem; except for NHN-WINTER-



Figure 10. *Ademon lagarosiphonae* Holotype female TYPH01926 (SANC) **A** habitus, lateral view **B** habitus, dorsal view **C** head and mesosoma, lateral view **D** head and mesosoma, dorsal view **E** head, anterior view **F** head, ventroanterior view.

FOR-R18; SAM-HYM-P092771 (SAMC) • 1 male: idem; except for NHN-WINTER-FOR-R19; SAM-HYM-P092772 (SAMC) • 1 male: idem; except for NHN-WINTER-FOR-R20; SAM-HYM-P092773 (SAMC) • 1 male: idem; except for NHN-WINTER-FOR-R21; SAM-HYM-P092774 (SAMC) • 1 male: idem; except for NHN-WINTER-FOR-R22; SAM-HYM-P092775 (SAMC) • 1 male: idem; except for NHN-WINTER-FOR-R23; SAM-HYM-P092776 (SAMC) • 1 male: idem; except for NHN-WINTER-FOR-R24; SAM-HYM-P092777 (SAMC) • 1 female:



Figure 11. *Ademon lagarosiphonae* Holotype female TYPH01926 (SANC) **A** head and mesosoma, latero-dorsal view **B** metasoma, lateral view **C** metasoma, dorsal view **D** metasomal terminal tergites, dorsal view.



Figure 12. *Ademon lagarosiphonae* Holotype female TYPH01926 (SANC) **A** scutellum, metanotum and propodeum, dorsal view **B** metasomal tergites 1–2, lateral view **C** forewing **D** data labels.

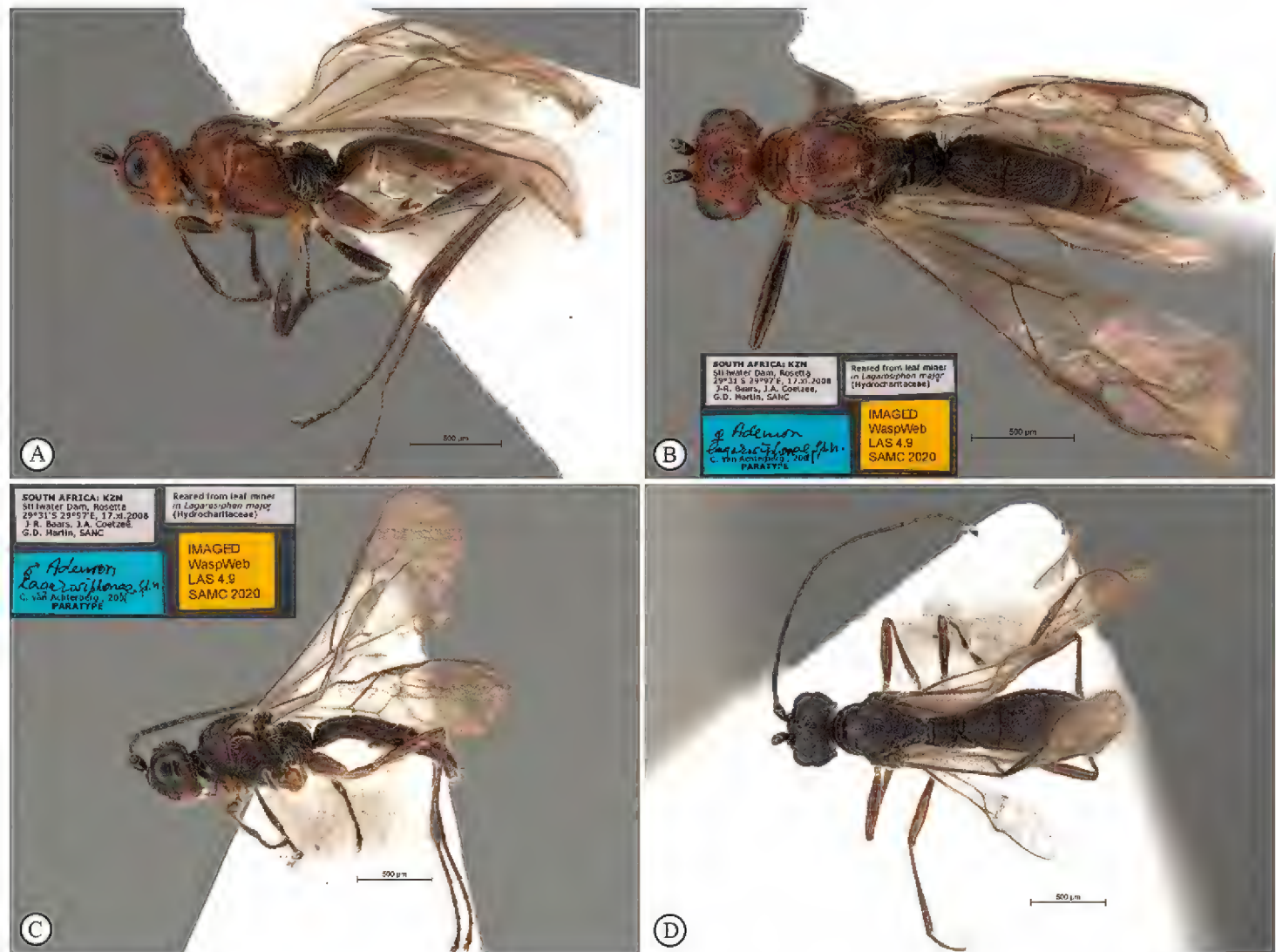


Figure 13. *Ademon lagarosiphonae* Paratype female (**A, B**) and paratype male (**C, D**) (SANC) **A** habitus, lateral view **B** habitus, dorsal view, inset: data labels **C** habitus, lateral view, inset: data labels **D** habitus, dorsal view.

idem; except for NHN-WINTER-FOR-R25; SAM-HYM-P092778 (SAMC) • 1 female: idem; except for NHN-WINTER-FOR-R26; SAM-HYM-P092779 (SAMC) • 1 female: idem; except for NHN-WINTER-FOR-R27; SAM-HYM-P092780 (SAMC) • 1 female: idem; except for NHN-WINTER-FOR-R28; SAM-HYM-P092781 (SAMC) • 1 male: idem; except for NHN-WINTER-FOR-R30; SAM-HYM-P092782 (SAMC) • 1 male: idem; except for NHN-WINTER-FOR-R31; SAM-HYM-P092783 (SAMC) • 1 male: idem; except for NHN-WINTER-FOR-R32; SAM-HYM-P092784 (SAMC) • 1 male: idem; except for NHN-WINTER-FOR-R33; SAM-HYM-P092785 (SAMC) • 1 female: idem; except for NHN-WINTER-FOR-R34; SAM-HYM-P092786 (SAMC) • 1 male: idem; except for NHN-WINTER-FOR-R35; SAM-HYM-P092787 (SAMC) • 1 male: idem; except for NHN-WINTER-FOR-R36; SAM-HYM-P092788 (SAMC) • 1 female: idem; except for NHN-WINTER-FOR-R37; SAM-HYM-P092789 (SAMC) • 1 female: idem; except for NHN-WINTER-FOR-R38; SAM-HYM-P092790 (SAMC) • 1 male: idem; except for NHN-WINTER-FOR-R39; SAM-HYM-P092791 (SAMC) • 1 male: idem; except for NHN-WINTER-FOR-R40; SAM-HYM-P092792 (SAMC) • 1 female: idem; except for NHN-WINTER-FOR-R41; SAM-HYM-P092793 (SAMC) • 1 female: idem; except for NHN-WINTER-FOR-R42; SAM-

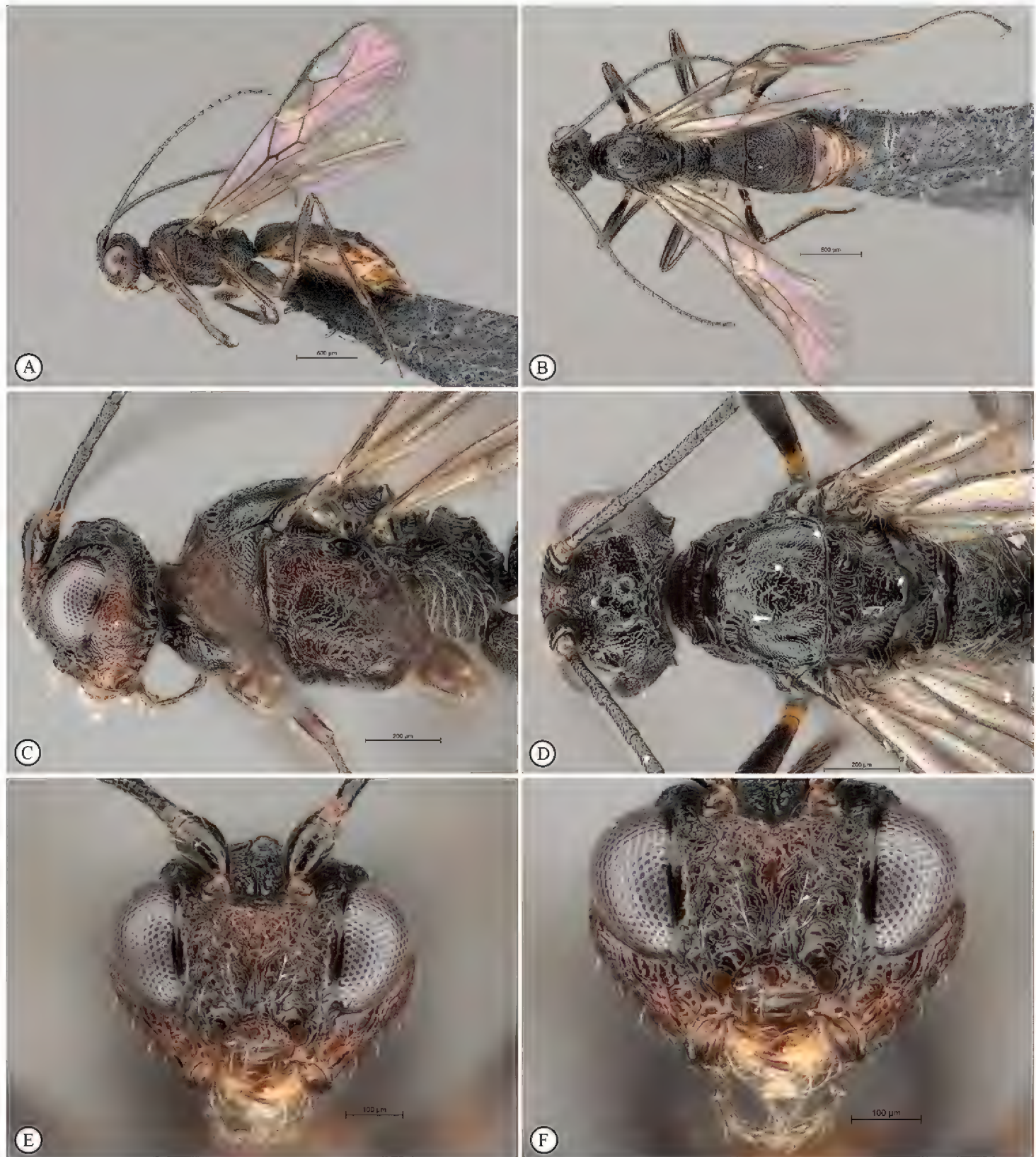


Figure 14. *Ademon lagarosiphonae* female SAM-HYM-P092756 (SAMC) **A** habitus, lateral view **B** habitus, dorsal view **C** head and mesosoma, lateral view **D** head and mesosoma, dorsal view **E** head, anterior view **F** head, ventroanterior view.

HYM-P092794 (SAMC) • 1 male: idem; except for NHN-WINTER-FOR-R43; SAM-HYM-P092795 (SAMC) • 1 female: idem; except for NHN-WINTER-FOR-R44; SAM-HYM-P092796 (SAMC) • 1 male: idem; except for NHN-WINTER-FOR-R45; SAM-HYM-P092797 (SAMC) • 1 male: idem; except for NHN-WINTER-FOR-R46; SAM-HYM-P092798 (SAMC) • 1 female: idem; except for NHN-WINTER-FOR-R47; SAM-HYM-P092799 • 1 male; KwaZulu-Natal; Midmar Dam; 29°32'21.35"S, 30°11'40.15"E; June 2019; R. Smith; Collected from



Figure 15. *Ademon lagarosiphonae* female SAM-HYM-P092756 (SAMC) **A** head and mesosoma, latero-dorsal view **B** metasoma, lateral view **C** metasoma, dorsal view **D** metasomal terminal tergites, dorsal view.

Egeria densa infestation with *Hydrellia egeriae* pupae; reared in lab; MDMR-FOR-R03; SAM-HYM-P092745 (SAMC) • 1 male: idem; except for MDMR-FOR-R06; SAM-HYM-P092754 (SAMC) • 1 male: idem; except for MDMR-FOR-R07; SAM-HYM-P092755 (SAMC) • 1 male: idem; except for MDMR-FOR-R08; SAM-HYM-P092758 (SAMC) • 1 male: idem; except for MDMR-FOR-R11; SAM-HYM-P092762 (SAMC) • 1 female: idem; except for MDMR-FOR-R12; SAM-HYM-P092763 (SAMC) • 1 male: idem; except for MDMR-FOR-R13; SAM-HYM-P092766 (SAMC).

Biology. Parasitoid of aquatic leaf-mining flies (Ephydriidae): *Hydrellia lagarosiphon* on *Lagarosiphon major* (Hydrocharitaceae) and *Hydrellia egeriae* on *Egeria densa* (Hydrocharitaceae).

Distribution. South Africa.

Comments. This species exhibits a disparate range of colour forms, from being completely black (Figs 14 A–F; 15 A–F; 16A, B) through to being completely yellowish-orange, as in the holotype (Figs 10 A–F; 11 A–D; 12 A, B) with intermediate grades present (Figs 13A, B; 16E, F). This extent of intra-specific colour difference is also present in the Palearctic type species of the genus, *A. descrezens* (Nees, 1812 [1811]) (van Achterberg and Prinsloo 2012).



Figure 16. *Ademon lagarosiphonae* females SAM-HYM-P092756 (**A–D**), SAM-HYM-P092796 (**E**), SAM-HYM-P092744 (**F**) (SAMC) **A** scutellum, metanotum and propodeum, dorsal view **B** metasomal tergites 1–2, lateral view **C** forewing **D** data labels **E** habitus, lateral view, inset: data labels **F** habitus, lateral view, inset: data labels. Figures **E** and **F** illustrate intermediate colour forms.

Family Eulophidae

Subfamily Entedoninae Foerster, 1856

Janicharis Gumovsky & Delvare, 2006

Type species. *Janicharis africanus* Gumovsky & Delvare, 2006, by monotypy and original designation.

***Janicharis africanus* Gumovsky & Delvare, 2006**

Fig. 17

Holotype. CAMEROON • female; Maroua, Djarengol; Malaise trap; 26.ix.1984; G. Delvare (MNHN not seen).

Paratypes. Cameroon • 3 females, idem (CIRAD) • 3 females, idem (RMNH) • NIGERIA • Oyo, Ibadan, IITA Compound; x.1987; J. Noyes (NHMUK) • MADAGASCAR • Lac Alaotra; on *Oryza sativa*, 17.x.1991; P. Bousses (CIRAD). Paratypes not seen.

Other material. SOUTH AFRICA • 1 female: *Eastern Cape*, East London, Nahoon river; 32°57'45.41"S, 27°54'41.59"E; NHN-WINTER-FOR-R02; July 2019; R. Smith; reared in laboratory; ex *Hydrellia egeriae* pupa collected from host plant *Egeria densa*; SAM-HYM-P092807 (SAMC) • 1 female: idem; except for NHN-WINTER-FOR-R29 and SAM-HYM-P092808 (SAMC) • 1 female: idem; except for: February 2019; R. Smith; Collected from *Egeria densa* infestation with *Hydrellia egeriae* pupae; SAM-HYM-P095099 (SAMC) • 1 male: idem; except for SAM-HYM-P095100 (SAMC).

Diagnosis. Uniquely defined by two large foveae situated antero-medially on propodeum; anterolateral propodeal strip wide, somewhat angulate above spiracle. Characters shared with morphologically-similar congeners: pronotum dorsally reduced, placed significantly below the level of mesoscutum; propodeum with anterolateral propodeal strips; anterior propodeum with basal cup and foveae on sides; metanotum with anteriorly-delimited foveae at sides of dorsellum; long postmarginal vein (Gumovsky et al. 2006).

Biology. Previously unknown. Here, we record the species as a parasitoid associated with immature stages of the aquatic ephydrid fly *Hydrellia egeriae*, having been reared from puparia along with specimens of *Ademon lagarosiphonae* and *Chaenusa seminervata* and hence is potentially a hyperparasitoid attacking the braconids rather than the fly. The eulophid subfamily Entedoninae harbours a wide range of life style strategies including species that are usually solitary or gregarious endoparasitoids (more rarely ectoparasitoids or hyper-parasitoids) of concealed dipteran, lepidopteran, coleopteran, hymenopteran or hemipteran larvae or rarely of eggs or pupae. *Janicharis africanus* is morphologically similar to the genera *Hakuna* Gumovsky & Delvare, 2006 and *Pediocharis* Bouček, 1988 (Gumovsky et al. 2006) and may, therefore, exhibit similar lifestyle strategies. The monotypic species *Hakuna matata* Gumovsky & Bouček, 2006 was reared from conical insect galls on a forest plant and each gall contained several pupae in separate cells; adult wasps emerged through a single hole at the apex of the gall. Based on these notes by the collector, Gumovsky et al. (2006) hypothesised *H. matata* to be a parasitoid of the gall former. Biology of *Pediocharis* is unknown and, together with the lack of detail concerning the biology of *Hakuna*, makes it difficult to predict whether *J. africanus* is, indeed, a hyper-parasitoid or not. A more remote possibility of morphological congeneric similarity for *Janicharis* is to *Chrysocharis* Foerster, 1856 (Gumovsky et al. 2006), but this genus contains a very broad range of lifestyle strategies, including endo- and ectoparasitoids and facultative hyperparasitoids (Yu et al. 2016), which does not provide any further enlightenment as to potential possibilities for *Janicharis*. The only recourse is to pursue direct investigation of the biology for *J. africanus* in the field.

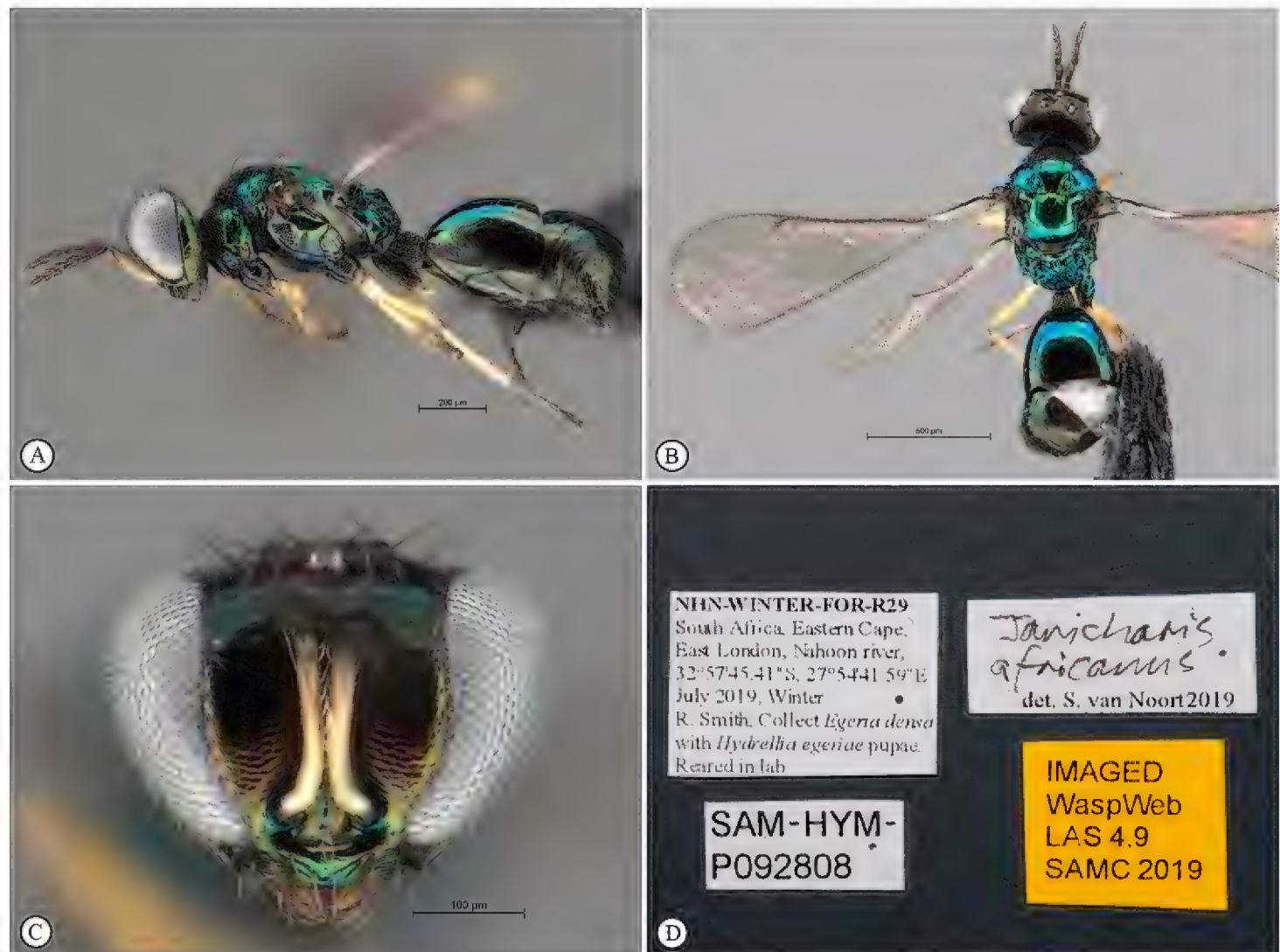


Figure 17. *Janicharis africanus* female SAM-HYM-P092808 (SAMC) **A** habitus, lateral view **B** habitus, dorsal view **C** head, anterior view **D** data labels.

Distribution. Cameroon, Nigeria, Madagascar and South Africa (new country record).

Comments. The reared specimens were identified by corroboration of morphological character attributes with the original description and type photographs of *J. africanus* (Gumovsky et al. 2006). The genus is monotypic.

Discussion

This paper contributes towards an understanding of the impact of parasitoid wasps on potential biocontrol agents of invasive waterweeds, specifically that of Brazilian waterweed, which is targeted by biocontrol agents in the genus *Hydrellia*. Numerous studies have been conducted in the New World and Oriental Region assessing, in particular, species delimitation and host relationships of *Chaenusa* species (Kula et al. 2006; Kula and Zolnerowich 2008; Kula 2009; Kula et al. 2009; Kula and Harms 2016). Efficacy of the biocontrol agent can potentially be affected by parasitoids and the extent to which these *Chaenusa* parasitoid wasps, as well as species of *Ademon* and *Janicharis*, affect these waterweed biocontrol programmes in various parts of the world is under

ongoing investigation, including in South Africa (Rosali Smith, in prep.). *Janicharis africanus* may be a hyper-parasitoid of the braconids, further complicating the impact of the biocontrol efficacy of *Hydrellia egeriae*, although if it is a hyper-parasitoid, this species should potentially have a positive impact on the biocontrol programme. Elucidation of the precise lifestyle strategy of *J. africanus* is under ongoing investigation by the Centre for Biological Control at Rhodes University (South Africa). Ramifications of adaptation by the indigenous parasitoids, documented in this paper, to introduced hosts released as potential biocontrol agents against targeted invasive species in South Africa, will be detailed in an accompanying publication (Smith, Coetzee, van Noort, in prep). This paper provides a taxonomic contribution towards resources that will facilitate identification of parasitoid wasps reared in the process of establishing effective control programmes for invasive waterweeds in Africa.

Acknowledgements

We thank Denis Brothers, Mark Shaw, Cees van Achterberg and an anonymous reviewer for their critical reviews that improved the manuscript. This research was funded through the Department of Environmental Affairs, Natural Resource Management Programme's Working for Water programme. Further funding for this work was provided by the South African Research Chairs Initiative of the Department of Science and Technology and the National Research Foundation of South Africa (grant nos. 89967, 109244 and 109683 to Martin Hill, SARCHi Chair). Simon van Noort was funded by a South African NRF FBIP grant no. 98115.

References

- Achterberg C van, Prinsloo GL (2012) Braconidae (Hymenoptera: Opiinae, Alysiinae) reared from aquatic leaf-mining Diptera on *Lagarosiphon major* (Hydrocharitaceae) in South Africa. *African Entomology* 20(1): 124–133. <https://doi.org/10.4001/003.020.0116>
- Baars JR, Coetzee JA, Martin G, Hill M, Caffrey J (2010) Natural enemies from South Africa for biological control of *Lagarosiphon major* (Ridl.) Moss ex Wager (Hydrocharitaceae) in Europe. *Hydrobiologia* 656(1): 149–158. <https://doi.org/10.1007/s10750-010-0427-0>
- Blanchard E (1845) Histoire Naturelle des Insecte Leurs Moeurs, Leurs Métamorphoses et Leur Classification ou Traite Elementaire D'entomologie. Tome Premier. Librairie de F. Didot Freres, Paris, 398 pp.
- Bouček Z (1988) Australasian Chalcidoidea (Hymenoptera). A biosystematic revision of genera of fourteen families, with a reclassification of species. CAB International, Wallingford, Oxon, U.K., Cambrian News Ltd. Aberystwyth, Wales, 832 pp.
- Bownes A (2014) Suitability of a leaf-mining fly *Hydrellia* sp., for biological control of the invasive aquatic weed, *Hydrilla verticillata* in South Africa. *BioControl* 59(6): 771–780. <https://doi.org/10.1007/s10526-014-9615-6>

- Cabrera Walsh G, Dalto YM, Mattioli FM, Carruthers RI, Anderson LW (2013) Biology and ecology of Brazilian elodea (*Egeria densa*) and its specific herbivore, *Hydrellia* sp., in Argentina. *BioControl* 58(1): 133–147. <https://doi.org/10.1007/s10526-012-9475-x>
- Coetzee JA, Bownes A, Martin GD (2011a) Prospects for the biological control of submerged macrophytes in South Africa. In: Moran VC, Hoffmann JN, Hill MP (Eds) *Biological Control of Invasive Alien Plants in South Africa (1992–2010)*. *African Entomology* 19(2): 469–487. <https://doi.org/10.4001/003.019.0203>
- Coetzee JA, Hill MP, Byrne MJ, Bownes A (2011b) A review of the biological control programmes on *Eichhornia crassipes* (C.Mart.) Solms (Pontederiaceae), *Salvinia molesta* D.S.Mitch. (Salviniaceae), *Pistia stratiotes* L. (Araceae), *Myriophyllum aquaticum* (Vell.) Verdc. (Haloragaceae) and *Azolla filiculoides* Lam. (Azollaceae) in South Africa. *African Entomology* 19(2): 451–468. <https://doi.org/10.4001/003.019.0202>
- Cook CDK, Urmi-König K (1984) A revision of the genus *Egeria* (Hydrocharitaceae). *Aquatic Botany* 19(1–2): 73–96. [https://doi.org/10.1016/0304-3770\(84\)90009-3](https://doi.org/10.1016/0304-3770(84)90009-3)
- De Stefani-Perez T (1902) Osservazioni biologiche sopra un Braconide aquatico, Giardinaia urinator, a descrizione di due altri Imenotteri nuovi. *Zoologische Jahrbücher Abteilung für Systematik* 15: 625–634. <https://doi.org/10.5962/bhl.part.19039>
- Deeming JC (2012) A new species of *Hydrellia* Rob. Desv. (Diptera: Ephydriidae) developing in *Lagarosiphon major* (Hydrocharitaceae) in South Africa. *African Entomology* 20(2): 217–221. <https://doi.org/10.4001/003.020.0206>
- Fischer M (1963) Die Opiinae der äthiopischen Region (Hymenoptera: Braconidae). *Beiträge zur Entomologie* 13(5/6): 662–747.
- Fischer M (1964) Die Opiinae der nearktischen Region (Hymenoptera, Braconidae). I. Teil. *Polskie Pismo Entomologiczne* 34: 197–530.
- Foerster A (1856) *Hymenopterologische Studien*. 2. Chalcidae und Proctotrupii. Aachen, 152 pp.
- Foerster A (1862) Synopsis der Familien und Gattungen der Braconiden. *Verhandlungen des Naturhistorischen Vereins der Preussischen Rheinlande und Westfalens* 19: 225–288.
- Granger C (1949) Braconides de Madagascar. *Mémoires de l'Institut Scientifique de Madagascar (A)* 2: 1–428.
- Gumovsky A, Bouček Z, Delvare G (2006) New genera and species of Afrotropical Entedoniinae (Hymenoptera, Eulophidae). *Zoologische Mededelingen, Leiden* 80–1(4): 73–85.
- Haliday AH (1833) An essay on the classification of the parasitic Hymenoptera of Britain, which correspond with the Ichneumonones minuti of Linnaeus. *Entomological Magazine* 1(3): 259–276.
- Haliday AH (1839) *Hymenoptera Britannica: Alysia*. Hippolytus Bailliere, London, 28 pp. <https://www.biodiversitylibrary.org/page/42580073>
- Hussner A, Stiers I, Verhofstad MJJM, Bakker ES, Grutters BMC, Haury J, van Valkenburg JLCH, Brundu G, Newman J, Clayton JS, Anderson LWJ, Hofstra D (2017) Management and control methods of invasive alien freshwater aquatic plants: A review. *Aquatic Botany* 136: 112–137. <https://doi.org/10.1016/j.aquabot.2016.08.002>
- June-Wells M, Vossbrinck CR, Gibbons R, Bugbee G (2012) The aquarium trade: A potential risk for nonnative plant introductions in Connecticut, USA. *Lake and Reservoir Management* 28(3): 200–205. <https://doi.org/10.1080/07438141.2012.693575>

- Kula RR (2009) A new species of *Chaenusa* (Hymenoptera: Braconidae) reared from *Hydrellia pakistanae* and *Hydrellia sarahae laticapsula* (Diptera: Ephydridae) infesting *Hydrilla verticillata* (Alismatales: Hydrocharitaceae) in India and Pakistan. *The Florida Entomologist* 92(1): 139–146. <https://doi.org/10.1653/024.092.0121>
- Kula RR, Harms N (2016) A new species of *Chaenusa* Haliday sensu lato (Hymenoptera: Braconidae) from the Nearctic Region. *Proceedings of the Entomological Society of Washington* 118(1): 101–108. <https://doi.org/10.4289/0013-8797.118.1.101>
- Kula RR, Zolnerowich G (2008) Revision of New World *Chaenusa* Haliday sensu lato (Hymenoptera: Braconidae: Alysiinae), with new species, synonymies, hosts, and distribution records. *Proceedings of the Entomological Society of Washington* 116(1): 1–60. <https://doi.org/10.4289/0013-8797-110.1.1>
- Kula RR, Zolnerowich G, Ferguson CJ (2006) Phylogenetic analysis of *Chaenusa* sensu lato (Hymenoptera: Braconidae) using mitochondrial NADH 1 dehydrogenase gene sequences. *Journal of Hymenoptera Research* 15: 251–265.
- Kula RR, Martínez JJ, Cabrera Walsh G (2009) Supplement to revision of New World *Chaenusa* Haliday sensu lato (Hymenoptera: Braconidae: Alysiinae). *Proceedings of the Entomological Society of Washington* 111(3): 641–655. <https://doi.org/10.4289/0013-8797-111.3.641>
- Leach WE (1815) Entomology. In: Brewster D (Ed.) *Edinburgh Encyclopaedia* (Vol. 9). <https://www.biodiversitylibrary.org/page/42186198>
- Nees von Esenbeck CG (1811) (1812 [1811]) *Ichneumonides Adsciti*, in *Genera et Familias Divisi*. *Magazin Gesellschaft Naturforschender Freunde zu Berlin* 5: 3–37.
- Nixon GEJ (1943) A revision of the European Dacnusiini (Hym., Braconidae, Dacnusiinae). *Entomologist's Monthly Magazine* 79: 20–34. <https://doi.org/10.1017/S0007485300023476>
- Planchon JE (1849) Sur L' *Anacharis alsinastrum*, plante anglaise supposée nouvelle avec un synopsis des espèces d' *Anacharis* en d' *Apalanthé* et des descriptions de quelques hydrocharidées nouvelles. *Annales des Sciences Naturelles. Botanique Series 3* 11: 79–80.
- Ridley HN (1886) On the freshwater Hydrocharideae of Africa and its islands. *Journal of the Linnean Society. Botany* 22: 232–241. [pl. 13] <https://doi.org/10.1111/j.1095-8339.1886.tb00466.x>
- Riegel GT (1950) A new genus and species of Dacnusiini (Hym.: Braconidae). *Entomological News* 61: 125–129.
- Robineau-Desvoidy JB (1830) *Essai sur les Myodaires. Mémoires Présentés par divers Savans a l'Académie Royale des Sciences de l'Institut de France, et Imprimés par son Ordre Sciences Mathématiques et Physiques* 2(2): 1–813.
- Rodrigues-Júnior FA, Mathis WN, Hauser M (2015) Argentine *Hydrellia* Robineau-Desvoidy (Diptera, Ephydridae): New species and key to identification. *Zootaxa* 3957(1): 131–136. <https://doi.org/10.11646/zootaxa.3957.1.11>
- Smith R, Mangan R, Coetzee JA (2019) Risk assessment to interpret the physiological host range of *Hydrellia egeriae*, a biocontrol agent for *Egeria densa*. *BioControl* 64(4): 447–456. <https://doi.org/10.1007/s10526-019-09942-4>
- van Noort S (2021) WaspWeb: Hymenoptera of the Afrotropical region. <http://www.waspweb.org> [Accessed: 4/January/2021]

- Viereck HL (1914) Type species of the genera of Ichneumon flies. United States National Museum Bulletin 83: 1–186. <https://doi.org/10.5479/si.03629236.83.1>
- Viereck HL (1916) One new genus and five new species of Ichneumon-flies. Proceedings of the Biological Society of Washington 29: 165–172.
- Vundla T, Blignaut JN, Crookes DC (2017) Aquatic weeds: To control or not to control. The case of the Midmar Dam, KwaZulu-Natal, South Africa. African Journal of Agricultural and Resource Economics 12(4): 412–429.
- Wesmael C (1835) Monographie des Braconides de Belgique. Nouveaux. Mémoires de l'Académie Royale des Sciences et Belles-lettres Bruxelles 9: 1–252.
- Wharton RA (2021) The Wharton lab. http://mx.speciesfile.org/projects/8/public/site/wharton_lab/home [Accessed: 4 January 2021]
- Wheeler GS, Center TD (2001) Impact of the biological control agent *Hydrellia pakistanae* (Diptera: Ephydriidae) on the submersed aquatic weed *Hydrilla verticillata* (Hydrocharitaceae). Biological Control 21(2): 168–181. <https://doi.org/10.1006/bcon.2001.0927>
- Wu Q, He J-H, Chen X-X (2014) The genus *Ademon* Haliday (Hymenoptera: Braconidae: Opiinae) from China, with descriptions of two new species. Zootaxa 3794: 294–298. <https://doi.org/10.11646/zootaxa.3794.2.8>
- Yarrow M, Marín VH, Finlayson M, Tironi A, Delgado LE, Fischer F (2009) The ecology of *Egeria densa* Planchon (Liliopsida: Alismatales): a wetland ecosystem engineer? Revista Chilena de Historia Natural 82(2): 299–313. <https://doi.org/10.4067/S0716-078X2009000200010>
- Yu DS, van Achterberg C, Horstman K (2016) Taxapad 2016, Ichneumonoidea 2015. Nepean, Ontario. Database on flash-drive.
- Zaykov AN (1986) Description of two new Dacnusiini species (Hymenoptera, Braconidae). Acta Zoologica Bulgarica 32: 52–55.